OFFICE OF NAVAL RESEARCH

END-OF-CONTRACT REPORT

PUBLICATIONS/PATENTS/PRESENTATIONS/HONORS/REPORT

for

Contract N00014-92-J-1183, Mod/Amend P00001

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Applications of Scanning Tunneling Microscopy to Electrochemisry

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End of Contract Report for ONR Contract N00014-92-J-1183

Our research during the last contract period (a one-year extension of ONR Contract N00014-88-K-0482) involved an evaluation of the efficacy of using partially insulated STM tips as ultramicroelectrodes in studies of heterogeneous electron transfer. We initially fabricated these electrodes to serve as tips for imaging surfaces in solutions that contain significant concentrations of electroactive species. The tips that we have prepared (by partially coating an etched Pt wire with molten glass) can have diameters as small as a few nanometers, and, by the nature of their small size, are useful in examining fundamental quantities such as the heterogeneous electron transfer rate constant for redox species such as $Ru(NH_3)_6^{3+/2+}$ and ferrocene$^{+/0}$.

During the contract period, we investigated the reproducibility of fabricating ultramicroelectrodes by this method and the stability of these tips in electrochemical environments. Our yields in fabricating tips by this method that expose small areas of metal surfaces (i.e., <100 nm^2) remain low (<5 %), and we have been unable to increase their yield. After fabricating well over 100 STM tips in this manner and examining their electrochemistry, we conclude that this procedure is well-suited for producing microelectrodes having diameters of 0.1 to 1 mm (and greater). Tips having smaller dimensions can be prepared, but are susceptible to cracking, fissuring, and related instabilities. Despite the problems and low yields associated with this method of preparation, it remains one of the only method presently available for preparing nanometer-scale electrodes.

The electrochemical investigations performed under this contract have demonstrated the necessity for reproducibly preparing ultramicroelectrodes of small dimension (i.e., <100 nm^2). To this end, these investigations into the use of partially insulated STM tips as ultramicroelectrodes have directed our attention towards the preparation of electrodes by lithographic methods. This work is being pursued currently.

References

None

Personnel on Contract N0014-92-J-1183

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